COMPLETE PROGRAMMING DOCUMENTATION

for

ECIP Expansion of Existing

Energy Monitoring and Control System (EMCS)

Fort Leonard Wood, Missouri

Prepared By:

E M C Engineers, Inc.

Atlanta, Georgia

for

U.S. Army Corps of Engineers

Kansas City, Missouri

December 1993

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
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TABLE OF CONTENTS

PART 1

PROJECT DEVELOPMENT BROCHURE

installation: Fort Leonard Wood, Missouri

project: ECIP Expansion of Existing EMCS (Energy Monitoring Control System)

project number
temporary: _____ program year FY95

permanent: _____ category code 80000

point of contact:

user
name Doug Cage date 7 July 1993

title Program Manager phone (314) 596-2177

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title Directorate of Engineering and Housing phone (314) 596-2121

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name Bob Miller date 7 July 1993

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other (A-E)
name _____ date _____

title _____ phone _____

autovon _____

reviewed by:

installation facility engineer
name _____ date _____

title _____ phone _____

autovon _____

approved by:

macom engineer
name _____ date _____

title _____ phone _____

autovon _____

project development brochure, PDB-1

DA FORM 5020-R, Feb 82

facility

Fort Leonard Wood, Missouri

project coordinator for using service

Doug Cage
(314) 596-2177

functional requirements summary, PDB-1

DA FORM 5020-1-R, Feb 82

OBJECTIVE

The objective of this project is to reduce energy consumption in 203 buildings by providing a new EMCS (Energy Monitoring Control System) to control and monitor systems.

REQUIREMENTS

Of the 203 buildings on the new EMCS, 45 buildings are currently controlled and monitored by an existing EMCS. The existing hardware in the 45 buildings shall be replaced, but the fiber optic (FO) cable to the hardware should be retained. The new EMCS shall include 158 additional buildings. The new EMCS should consist of new PC-based front-end computers communicating to building Remote Control Units, Auxiliary Control Units, and Unitary Control Units. There are 3,826 EMCS points in the 158 additional buildings. A new data transmission system, consisting of contractor-installed aerial and underground FO cable shall be provided for all data communication needs to the 158 buildings.

The EMCS configuration shall be based on the Huntsville Division Corps of Engineers current draft guide specifications. These specifications include the following main components:

- PC-based front-end computers, specified to be the fastest available microprocessor at the time (currently an Intel 80486-66 mHz).
- Remote Control Units (RCU), microprocessor-based field panels which coordinate communications and some high level control coordination with ACUs and UCUs. There is typically one RCU per 64 ACUs and UCUs.
- Auxiliary Control Units (ACU), microprocessor-based panels set up to control and monitor single pieces of equipment, or groups of equipment. ACUs are typically used for large systems.
- Unitary Control Units (UCU), microprocessor-based panels set up to control and monitor single pieces of equipment, or groups of equipment. UCUs are typically used for terminal devices (such as variable air volume boxes) and fan coils.
- Central Operator Station (COS), is the site where the front-end computers are located and the system operator technician operates the EMCS.
- Communication Processor and Communication Network Interface, provide the interface and management of the networks. Different networks could exist between COSs, between the COS and RCUs, and between RCUs, ACUs, and UCUs.

The data transmission media (DTM) shall be FO cable. The existing EMCS utilizes fiber optic DTM. The Johnson Controls EMCS which preceded the current EMCS was turned off and removed because the coaxial communication system was prone to lightning strikes. Fort Leonard Wood is in a high lightning area of the United States.

functional requirements summary, PDB-1

REQUIREMENTS (continued)

Sensors and actuators shall be provided to monitor and control the remote points of the EMCS. The sensors should include, but not be limited to the following:

- Temperature sensors with transmitters
- Relative humidity sensors with transmitters
- Pressure sensors
- Pressure switches
- Watt meters
- Amp meters
- Flow meters
- Current transformers
- Status relays
- Start/stop control relays
- Electric/pneumatic transducers
- Pneumatic/electric transmitters.

The EMCS at Fort Leonard Wood is operated and maintained by the EMCS manager and the system operator technician. No major maintenance or calibration work would be done by this staff. The staff, however, should be able to troubleshoot, exchange defective boards on computer-based hardware, and perform similar tasks. Two additional EMCS operators should be provided to operate the EMCS.

Correct and continuing maintenance of EMCS equipment is essential if the maximum benefits of the system are to be realized. Without proper maintenance, the reliability of an EMCS will rapidly deteriorate, thereby reducing its energy conservation capability and benefits.

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
A-1	Cost estimates for each primary and supporting facility	R		✓	
A-2	Telecommunications system coordination with USACC and authorization for exceptions	NR			
A-3	Coordination with state and local governmental requirements (blind vendors, medical facilities, construction and operating permits, clearinghouse ccoordination, etc.)	NR			
A-4	Assignment of airspace	NR			
A-5	Economic analysis of alternatives	R		✓	
A-6	Approval for new starts	NR			
A-7	International balance of payments (IBOP) coordination with U.S. European command and NATO—overseas cost estimates and comparables (include rate of exchange used in estimates)	NR			
A-8	Impact on historic places—on site survey by authorized archeologist and coordination with state historic preservation officer and advisory council on historic preservation	NR			
A-9	Exceptions to established criteria	NR			
A-10	Coordination with various staff agencies (Provost Marshall-physical security, etc.)	R		✓	
A-11	Identification of related or support projects (so projects can be coordinated)	R	D		
A-12	Required completion date	R	A		
	Other Special Considerations (List and number items)				

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E — Other (Check Comments Attached and explain)

documentation checklist

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B. SITE DEVELOPMENT

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
B-1	Consultation with the District Office to determine and evaluate flood plain hazards	NR			
B-2	Preparation, submission, and/or approval of new				
(A)	General Site Plan	NR			
(B)	Annotated General Site Plan	NR			
(C)	Sketch Site Plan	NR			
(D)	Facilities Requirements Sketch	NR			
B-3	Preparation of				
(A)	Site Survey	NR			
(B)	Subsoil information	NR			
B-4	Approval by Department of Defense Explosive Safety Board (DDESB) for Safety Site Plan	NR			
	Other Site Development Considerations (List and number items)				

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DA FORM 5023-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
C-1	Reconciliation with troop housing programs and requirements	NR			
C-2	Evaluation of existing facilities (including degree of utilization)	R		✓	
C-3	Approval for removal and relocation of existing useable facilities	NR			
C-4	Evaluation of off-post community facilities	NR			
C-5	Storage and maintenance facilities (including nuclear weapons)	NR			
C-6	Coordination hospitals, medical and dental facilities with Surgeon General	NR			
C-7	Coordination of aviation facilities with FAA	NR			
C-8	Coordination air traffic control and navigational aids with USACC	NR			
C-9	Tabulation of types and numbers of aircraft	NR			
C-10	Evaluation of laboratory, research and development, and technical maintenance facilities	NR			
C-11	Coordination chapels with Chief of Chaplains	NR			
C-12	Review food service facilities by USATSA	NR			
C-13	Automated data processing system or equipment approvals—cost analysis when ADP and/or communication centers not co-located with related facilities	NR			
C-14	Coordination postal facilities with U.S. Postal Service Regional Director	NR			
C-15	Laundry and dry cleaning facilities coordination with ASD(I&L)	NR			
C-16	Tenant facilities coordination with installation where sited	NR			
C-17	Facilities for or exposed to explosions, toxic chemicals, or ammunition—review by DDESB (See also Item B-4)	NR			
C-18	Analysis of deficiencies	R		✓	
C-19	Consideration of alternatives	R		✓	
C-20	Determination whether occupants will include physically handicapped or disabled persons	R		✓	
C-21	As-build drawings for alterations or additions	R		✓	
C-22	Availability of Standard Design or site adaptable designs	NR			
	Other Architectural & Structural (List and number items)				

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DA FORM 5023-C-R, Feb 82

D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-1	Fuel considerations and cost comparison analysis	NR			
D-2	Energy requirements appraisal (ERA)	R		✓	
D-3	Conformance with DOD Energy Reduction requirements	R		✓	
D-4	Evaluation of existing and/or proposed utility systems	NR			
	Other Mechanical and Utility Systems (List and number items)				
D-5	Evaluation of existing and/or proposed EMCS	R		✓	

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DA FORM 5023-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be * Determined	Comment Attached	Document Attached
E-1	Environmental impact assessment	NR			
E-2	EIA conclusions require Environmental Impact Statement	NR			
E-3	Determination of health, environmental or related hazards. Assistance to determine existence of any health, environmental or related hazard may be requested from Aberdeen Proving Ground, MD 21010, the Office of the Surgeon General, Attn: DASG-HCH (Army Environmental Hygiene Agency)	NR			
E-4	Air/water pollution permit, coordination with agencies and compliance with standards at Federal, state and local level	NR			
E-5	Corrective measures associated with Environmental Impact Statements or assessment—list separately and evaluate.	NR			
	Other environmental considerations (list and number items)				

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COMMENTS

DOCUMENTATION CHECKLIST

Item	Comments
A-1	See the cost estimates in Part 3, "Economic Analysis".
A-5	Alternatives to the EMCS in relation to the energy conservation project were considered as a part of the study.
A-10	Scheduling and clearances for access to permanent buildings must be considered.
C-2	Evaluations concerning the thermal characteristics of the subject facilities were completed as an integral part of the energy study.
C-18	Deficiencies in efficient energy consumption have been identified and corrections have been proposed.
C-19	Alternatives to the EMCS with respect to the energy study were considered.
C-20	The scope of work will not affect accessibility of the handicapped.
C-21	As-built drawings for project facilities are available for check-out and reproduction from DEH.
D-2	The Energy Requirements Appraisal was completed and included in Part 3.
D-3	Implementation of this project will result in reduced energy consumption.
D-5	Evaluations concerning the existing EMCS and a proposed EMCS were completed as an integral part of the energy study.

A. SPECIAL CONSIDERATIONS

	ITEM	Required or Not Required	To Be * Determined	Comment Attached	Document Attached
A-1	Factors of risk, restriction or unusual circumstance expected to increase costs beyond applicable area averages	NR			
A-2	Construction phasing requirements	R	A		
A-3	Functional support equipment (mechanical, electrical, structural, and security) to be built in	NR			
A-4	Equipment in place and justification	NR			
A-5	Other equipment and furniture (O&MA, OPA) and costs	NR			
A-6	Special studies and tests (hazards analyses, compatibility testing, new technology testing, etc.)	NR			
A-7	Type of construction (permanent, temporary, semi-permanent)	NR			
A-8	Government furnished equipment (quantities, procurement time, availability and special handling and storage requirements). Funds used for procurement.	NR			
	Other special considerations (list and number items)				

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technical data checklist

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B. SITE DEVELOPMENT

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
B-1	Construction restrictions or guidelines pertaining to				
(A)	site access and preferred construction routes	NR			
(B)	Airfield clearance, explosive storage, working hours, safety, etc.	NR			
(C)	Facilities and/or functions or adjoining areas (structures, materials, impact)	NR			
B-2	Real estate actions (acquisition, disposal, lease, right-of-way)	NR			
B-3	Demolition/relocation required (data)				
(A)	Special considerations due to explosives/radioactivity/ chemical contamination/asbestos emissions/toxic gases	NR			
(B)	Restrictions on disposal of demolished/relocated material including hazardous waste	NR			
B-4	Pavement types and requirements (including traffic surveys and MTMC coordination)	NR			
B-5	Landscape considerations				
(A)	Protection of existing vegetation	NR			
(B)	Stockpile topsoil	NR			
	Other Site Development (List and number items)				

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technical data checklist

DA FORM 5024-B-R, Feb 82

C. ARCHITECTURAL & STRUCTURAL

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
C-1	Vibration-producing equipment requiring isolation	NR			
C-2	Seismic zone and other design load criteria (typhoon, hurricane, earthquake loads, high or low loss potential)	NR			
C-3	Protective shelter evaluation and resistant design criteria (conventional/nuclear blast and radiation, chemical/biological)	NR			
C-4	Unusual foundation requirements (pier, pile, caisson, deep foundations, mat, special treatment, permafrost areas, soil bearing)	NR			
C-5	Designation and strength of units to be accommodated	NR			
C-6	Requirements and data for special design projects	NR			
C-7	Unusual floor and roof loads (safes, equipment)	NR			
C-8	Security features (arms rooms, vaults, interior secure areas)	NR			
	Other Architectural & Structural (List and number items)				

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technical data checklist

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D. MECHANICAL, ELECTRICAL, & UTILITY SYSTEMS

	ITEM	Required or Not Required	* To Be Determined	Comment Attached	Document Attached
D-1	Special mechanical requirements or considerations (elevator, crane, hoist, etc.)	NR			
D-2	Special peak usage periods and peak leveling techniques	R	D		
D-3	Maintenance considerations (accessibility of equipment, compatibility with existing equipment)	R	D		
D-4	Plumbing—availability, general system type and characteristics (proposed and/or existing, incl. compressed air and gas)	NR			
D-5	Heating—availability, general system type and characteristics (proposed and/or existing)	NR			
D-6	Ventilating, air condition/refrigeration—availability, general system type and characteristics (proposed and/or existing)	NR			
D-7	Electrical—availability, general system type and characteristics incl. airfield lighting, communication, etc. (proposed and/or existing)	NR			
D-8	Water supply/waste treatment—availability, general system type and characteristics (proposed and/or existing)	NR			
D-9	Energy requirements/fuel conversion (sources, availability, loads, types of fuel, etc.)	NR			
D-10	Solar energy evaluation	NR			
	Other Mechanical & Utility Systems (List and number items)				
D-11	EMCS - availability, general systems type and characteristics (proposed and/or existing)	R	D		

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technical data checklist

DA FORM 5024-D-R, Feb 82

E. ENVIRONMENTAL CONSIDERATIONS

ITEM		Required or Not Required	* To Be Determined	Comment Attached	Document Attached
E-1	Waste water treatment, air quality, and solid waste disposal criteria	NR			
	Other Environmental Considerations (List and number items)				

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DA FORM 5024-E-R, Feb 82

F. FIRE PROTECTION

ITEM		Required or Not Required	* To Be Determined	Comment Attached	Document Attached
F-1	Special fire protection systems or features (detection and suppression equipment, hazards, etc.)	NR			
	Other Fire Protection Considerations (List and number items)				

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technical data checklist

DA FORM 5024-F-R, Feb 82

PART 2

DD FORM 1391

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 27 DEC 93
3. INSTALLATION AND LOCATION Fort Leonard Wood, Missouri	4. PROJECT TITLE ECIP Expansion of Existing EMCS (Energy Monitoring Control System)	

5. PROGRAM ELEMENT	6. CATEGORY CODE 80000	7. PROJECT NO.	8. PROJECT COST ($000) **3,410**

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Primary Facility: Expand the existing EMCS to include 158 additional buildings. Provide PC-based front-end computers, Central Operator Station, Communication Processor and Network Interface, Remote Control Units, Auxiliary Control Units, Unitary Control Units, sensors, and actuators. Replace field hardware in 45 buildings on the existing EMCS and retain fiber optic (FO) cable to these buildings. Provide FO cable to the 158 additional buildings.	LS			2,772
Supporting Facilities: Design Cost (6%)	LS			166
Estimated Contract Cost				2,938
Contingency (10%)	LS			294
Subtotal				3,232
Supervision, Inspection and Overhead (5.5%)	LS			178
TOTAL REQUEST				3,410

10. DESCRIPTION OF PROPOSED CONSTRUCTION

The proposed construction includes a new EMCS at Fort Leonard Wood to control and monitor systems in 158 new buildings and replace field hardware in the original 45 buildings on the existing EMCS. The new EMCS should consist of PC-based front-end computers communicating to building Remote Control Units, Auxiliary Control Units, and Unitary Control Units, to control and monitor 4,959 points, of which 3,826 are new points and 1,133 are existing points. A new data transmission system, consisting of contractor-installed aerial and underground FO cable shall be provided for all data communication needs to the 158 new buildings. The FO cable to the 45 buildings on the existing EMCS shall be retained and used for the replacement field hardware.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 27 DEC 93
3. INSTALLATION AND LOCATION Fort Leonard Wood, Missouri		
4. PROJECT TITLE ECIP Expansion of Existing EMCS (Energy Monitoring Control System)		5. PROJECT NUMBER

11. REQUIREMENT

PROJECT:

Expand the existing EMCS to include 158 additional buildings. Provide PC-based front-end computers, Central Operator Station, Communication Processor and Network Interface, Remote Control Units, Auxiliary Control Units, Unitary Control Units, sensors, and actuators. Replace field hardware in 45 buildings on the existing EMCS and retain fiber optic (FO) cable to these buildings. Provide FO cable to the 158 additional buildings. Provide two additional EMCS operators for the EMCS.

REQUIREMENT:

This project is required to reduce the fuel oil consumption, LPG consumption, electrical consumption, and electrical demand of HVAC equipment, boilers, chillers, and electric domestic hot water heaters through EMCS control technology.

CURRENT SITUATION:

Fort Leonard Wood has an existing EMCS in 45 buildings. The final construction and acceptance of this EMCS was completed in the summer of 1991. The EMCS configuration includes dual Digital Equipment Corporation (DEC) MicroVax 3100 minicomputers, three DEC VaxStation 3100's with 19" color monitors, plus peripherals and a failover controller. Six FO data transmission cables facilitate the communications from the master control room to the buildings.

Discussions with the EMCS operators at Fort Leonard Wood regarding the existing EMCS indicated the system was operational and was providing them significant utility savings (especially through electrical demand limiting). The discussions also revealed some problems and defects associated with the existing EMCS.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 27 DEC 93
3. INSTALLATION AND LOCATION Fort Leonard Wood, Missouri		
4. PROJECT TITLE ECIP Expansion of Existing EMCS (Energy Monitoring Control System)		5. PROJECT NUMBER

IMPACT IF NOT PROVIDED:

If this project is not funded, a reduction of 195,777 MBtu/yr cannot be achieved. Excessive amounts of fuel oil, LPG, natural gas and electricity will continue to be used, and there will be no contribution to energy reduction goals established for U.S. Army facilities by Army Headquarters.

ADDITIONAL:

This project complies with the scope and design criteria of the "Energy Conservation Investment Program (ECIP) Guidance". The project has a Savings to Investment Ratio (SIR) of 3.0 and a simple payback of 3.2 years. The implementation of this project will provide an annual energy savings of 195,777 MBtu and an annual total dollar savings of $1,037,666.

Project validation will be through the use of electric and gas meters on the existing utilities to record consumption basewide.

PART 3

SUPPORTING DATA

Date: December 1993
Project Number:
Project Title: ECIP Expansion of Existing EMCS (Energy Monitoring Control System)

PROGRAMMING DOCUMENTATION
Supporting Data

Method of Analysis:

A series of computer programs and analysis techniques were used to select the buildings, systems, and functions which would provide an optimum EMCS configuration for Fort Leonard Wood. This main analysis program, written by EMC Engineers, Inc., calculates the energy savings which result when a particular EMCS function is applied to a specific mechanical system type. Savings are calculated on a function-by-function basis for each system. Typical system configurations were developed for a range of AHUs, pumps, boilers, and chillers. The calculations follow the basic guidelines described in "CR82.030, Standardized EMCS Energy Savings Calculations, Naval Civil Engineering Laboratory".

Energy savings were calculated using energy constants derived by computer energy simulations of representative buildings and weather conditions at Fort Leonard Wood. The TRACE and BEACON computer programs were used to execute the computer energy simulations. Both programs perform hourly energy calculations and can predict the energy consumption which would result from various heating and cooling systems and operational settings. The energy savings for the buildings not simulated were extrapolated using the energy constants derived for the representative buildings.

The functions provided in the analysis program include:

- Scheduled start/stop
- Optimum start/stop
- Duty cycling
- Demand start/stop of motors
- Demand start/stop of chillers
- Economizer
- Direct digital control
- Unoccupied setback
- Hot water outside air reset
- Chilled water temperature reset
- Ventilation/recirculation damper control.

The analysis computer program also developed the I/O summary table for the proposed functions for each system, estimated the cost for the hardware to implement the functions, and split the cost between function groups. Savings and costs computed by the analysis program were then entered into the spreadsheet program to calculate the economics for various functions.

The spreadsheet program has special features which allow calculations, selection of items, sorting, and prioritization of items. This system was used for the following purposes:

- To perform economic analyses on EMCS functions, systems, and buildings.

- To sort data on the benefits provided by the EMCS to obtain the optimum system.

Based on the final selection of functions, systems, and buildings, the total savings and costs were developed into an EMCS project.

Date: December 1993
Project Number:
Project Title: ECIP Expansion of Existing EMCS (Energy Monitoring Control System)

PROGRAMMING DOCUMENTATION
Supporting Data

Assumptions:

Electric cost = $0.025/kWh

Electric demand cost = $6.185/kW/month

No. 2 fuel oil cost = $5.4398/MBtu

No. 6 fuel oil cost = $4.4312/MBtu

Liquified petroleum gas cost = $5.6305/MBtu

Calculations:

Annual Recurring Cost = Annual Maintenance Manhours Savings + Annual Electrical Demand Savings + (Annual Staff Cost) + (Annual Maintenance Cost)

= $58,644 + $38,118 + ($66,000) + ($114,533)

= ($83,771)

Economic Analysis:

TABLE 3-1
ECONOMIC SUMMARY

Project	Annual Energy Savings (MBtu/yr)	Total Annual Cost Savings ($/yr)	Simple Payback (yrs)	SIR
ECIP Expansion of Existing EMCS (Energy Monitoring Control System)	195,777	1,037,666	3.2	3.0

The Life Cycle Cost Analysis (LCCA) for the ECIP project is presented on page 3-3. The economic summary for the 158 additional buildings on the EMCS is presented in Table 3-2 beginning on page 3-4.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: FTLWOOD
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.065
INSTALLATION & LOCATION: FT. LEONARD WOREGION NOS. 7 CENSUS: 2
PROJECT NO. & TITLE: 3204-000 EMCS FEASIBILITY STUDY
FISCAL YEAR 1993 DISCRETE PORTION NAME: EXPANSION AN EXISTING EMCS
ANALYSIS DATE: 12-27-93 ECONOMIC LIFE 10 YEARS PREPARED BY: KC

1. INVESTMENT

A. CONSTRUCTION COST	$ 2772023.
B. SIOH	$ 152462.
C. DESIGN COST	$ 166322.
D. SALVAGE VALUE COST	-$ 0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$ 3090807.

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ 7.32	16701.	$ 122334.	8.08	988456.
B. DIST	$ 5.44	98345.	$ 534977.	9.44	5050184.
C. RESID	$ 4.43	61870.	$ 274158.	10.90	2988326.
D. NAT G	$ 5.63	18861.	$ 106197.	9.35	992941.
E. COAL	$ .00	0.	$ 0.	8.51	0.
F. TOTAL		195777.	$ 1037666.		$ 10019910.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)		$ -83771.
(1) DISCOUNT FACTOR (TABLE A)	7.87	
(2) DISCOUNTED SAVING/COST (3A X 3A1)		$ -659278.
C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)		$ -659278.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 3306570.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)_____
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE)) $ 953895.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 9360629.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= 3.03
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 3.24

TABLE 3–2
BUILDING ECONOMIC SUMMARY

BLDG NO.	BLDG DESCRIPTION	kWh SVGS. PER YR	kW SVGS. PER YR	MMBtu F. OIL #2 SVGS. PER YR	MMBtu F. OIL #6 SVGS. PER YR	MMBtu LPG SVGS. PER YR	LABOR HOURS SVGS. PER YR	$ COST SVGS. PER YR	DO PNT.	AO PNT.	DI PNT.	AI PNT.	TOTAL BLDG. PNT.	$ CONST. COST	$ ACU COST	$ FIELD HARDWARE COST	TOTAL $ DISC. SAVING	SIR
5265	DOL	471,757	75	64,515			106	365,175	34	52	47	85	218	53,577	14,652	68,229	3,427,976	50.2
1750	Administration	195,947	22	6,945			19	43,166	5	5	5	21	36	9,043	2,664	11,707	400,174	34.2
7391	NCO Club	162,580	321			9,191	38	58,505	13	15	20	18	66	15,101	3,996	19,097	538,522	28.2
730	Barracks, w/o a/c		55		2,992		6	13,709	4	4	4	6	18	5,512	1,332	6,844	148,962	21.8
731	Barracks, w/o a/c		55		2,992		6	13,709	4	4	4	6	18	5,512	1,332	6,844	148,962	21.8
736	Barracks, w/o a/c		55		2,992		6	13,709	4	4	4	6	18	5,512	1,332	6,844	148,962	21.8
737	Barracks, w/o a/c		55		2,992		6	13,709	4	4	4	6	18	5,512	1,332	6,844	148,962	21.8
738	Barracks, w/o a/c		55		2,992		6	13,709	4	4	4	6	18	5,512	1,332	6,844	148,962	21.8
815	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
816	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
817	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
818	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
819	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
827	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
828	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
829	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
830	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
831	Barracks, w/o a/c	13,922	55		2,987		15	14,205	5	5	5	8	23	7,189	1,332	8,521	152,921	17.9
1350	Reserve Center	56,541	179	2,863			22	18,498	9	5	12	16	42	8,833	2,664	11,497	170,687	14.8
4109	Officers Club	108,910	40	4,993			38	30,836	16	11	18	22	67	15,277	3,996	19,273	286,128	14.8
2105	Mess Hall	143,870	198			1,541	22	13,908	5	6	9	16	36	7,919	2,664	10,583	123,443	11.7
1740	Mess Hall	105,973	30	3,589			19	22,706	6	17	6	31	60	16,862	3,996	20,858	210,028	10.1
680	Motor Pool	8,593	3			366		2,293	3		3	2	8	1,108	1,332	2,440	21,144	8.7
990	Motor Pool	8,593	3			366		2,293	3		3	2	8	1,108	1,332	2,440	21,144	8.7
991	Motor Pool	8,593	3			366		2,293	3		3	2	8	1,108	1,332	2,440	21,144	8.7
998	Motor Pool	8,593	3			366		2,293	3		3	2	8	1,108	1,332	2,440	21,144	8.7
999	Motor Pool	8,593	3			366		2,293	3		3	2	8	1,108	1,332	2,440	21,144	8.7
672	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
673	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
681	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
772	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
773	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
780	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
781	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
872	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
873	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
880	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
881	Motor Pool	8,593	3	366				2,223	3		3	2	8	1,108	1,332	2,440	20,671	8.5
1711	PX	70,619	14	823			11	6,529	3	3	3	13	22	5,979	1,332	7,311	58,846	8.0
1025	Administration/Supply	12,634	9	629			6	3,905	3	2	3	5	13	3,481	1,332	4,813	36,207	7.5
837	Mess Hall	145,686	50		419		10	5,992	4	5	6	9	24	6,068	1,332	7,400	53,777	7.3
3210	Dayroom	23,483	6			257		2,074	2	2		2	6	1,448	1,332	2,780	18,595	6.7
1027	Mess Hall	104,029	50	769			19	7,446	6	5	8	13	32	7,550	2,664	10,214	65,878	6.4
735	Mess Hall	109,351	50		1,038		28	8,162	9	5	11	19	44	9,773	2,664	12,437	79,220	6.4
739	Mess Hall	109,351	50		1,038		28	8,162	9	5	11	19	44	9,773	2,664	12,437	79,220	6.4
630	Mess Hall	104,029	50		769		19	6,670	6	5	8	13	32	7,550	2,664	10,214	63,735	6.2
653	Mess Hall	104,029	50		769		19	6,670	6	5	8	13	32	7,550	2,664	10,214	63,735	6.2
657	Mess Hall	104,029	50		769		19	6,670	6	5	8	13	32	7,550	2,664	10,214	63,735	6.2

TABLE 3–2
BUILDING ECONOMIC SUMMARY
(Continued)

BLDG NO.	BLDG DESCRIPTION	kWh SVGS. PER YR	kW SVGS. PER YR	MMBtu F. OIL #2 SVGS. PER YR	MMBtu F. OIL #6 SVGS. PER YR	MMBtu LPG SVGS. PER YR	LABOR HOURS SVGS. PER YR	$ COST SVGS. PER YR	DO PNT.	AO PNT.	DI PNT.	AI PNT.	TOTAL BLDG. PNT.	$ CONST. COST	$ ACU COST	$ FIELD HARDWARE COST	TOTAL $ DISC. SAVING	SIR
836	Mess Hall	104,029	50		769		10	6,503	6	5	8	13	32	7,550	2,664	10,214	62,379	6.1
2100	Reception Center	333,272	454			1,053	61	18,197	21	19	26	26	92	20,555	6,660	27,215	154,680	5.7
802	Day Care	19,101	37			190	12	1,994	4		4	4	12	1,862	1,332	3,194	17,483	5.5
1705	Admin./Courtroom	60,671	75	344			13	4,094	3	3	5	11	22	5,677	1,332	7,009	35,651	5.1
3215	Central Plant	13,138	430			22	16	3,409	12		8	4	24	4,226	1,332	5,558	27,791	5.0
636	Brigade HQ	43,199	69		427		7	3,528	7	5	5	8	25	5,494	1,332	6,826	33,979	5.0
1383	Auto Craft Shop	6,593				385		2,333	7		7	7	21	3,031	1,332	4,363	21,600	5.0
637	Chapel	116,378	25		621		6	5,925	9	8	8	13	38	8,674	2,664	11,338	55,801	4.9
1390	Reserve Motor Pool	35,525	37	674			18	5,120	8	3	9	13	33	7,107	2,664	9,771	46,371	4.7
4102	BEQ					374	3	2,160		2	2	4	8	2,917	1,332	4,249	20,131	4.7
4103	VOQ					346	3	2,005		2	2	4	8	2,917	1,332	4,249	18,678	4.4
639	PX	30,284	65		299		14	2,743	6	2	6	10	24	4,768	1,332	6,100	25,993	4.3
826	Gym	12,626			333		15	2,070	5		5	10	20	3,705	1,332	5,037	20,982	4.2
6150	Admin./Maintenance	39,675	32	1,121			20	7,655	6	14	7	24	51	13,065	3,996	17,061	70,159	4.1
4100	BEQ					321	3	1,863		2	2	4	8	2,917	1,332	4,249	17,351	4.1
4101	BEQ					321	3	1,863		2	2	4	8	2,917	1,332	4,249	17,351	4.1
1022	Battalion HQ	55,286	78	348			11	3,962	4	4	6	13	27	7,286	1,332	8,618	34,607	4.0
2273	Entomology	8,251	19	274			14	2,075	4	2	7	6	19	3,397	1,332	4,729	18,804	4.0
650	Battalion HQ	55,286	78		348		11	3,611	4	4	6	13	27	7,286	1,332	8,618	33,638	3.9
732	Battalion HQ	55,286	78		348		11	3,611	4	4	6	13	27	7,286	1,332	8,618	33,638	3.9
740	Battalion HQ	55,286	78		348		11	3,611	4	4	6	13	27	7,286	1,332	8,618	33,638	3.9
842	Battalion HQ	55,286	78		348		11	3,611	4	4	6	13	27	7,286	1,332	8,618	33,638	3.9
1023	Battalion HQ	55,286	22	348			5	3,504	4	4	6	13	27	7,286	1,332	8,618	30,895	3.6
498	Old Commisary	125,747	210			643	41	8,827	20	13	18	28	79	16,243	5,328	21,571	75,981	3.5
1704	Battalion HQ	52,172	27	387			14	3,835	5	3	5	17	30	7,854	2,664	10,518	33,859	3.2
626	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
633	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
655	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
656	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
733	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
734	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
751	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
752	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
823	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
824	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
840	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
841	Administration/Supply	1,174	9		246		3	1,231	2	2	2	3	9	2,740	1,332	4,072	13,088	3.2
2399	Vet Clinic	34,286	53	132			8	2,047	3	2	5	10	20	4,219	1,332	5,551	17,528	3.2
1703	Battalion HQ	67,952	45	503			16	5,001	6	9	5	23	43	11,703	2,664	14,367	44,143	3.1
1018	Medical Clinic	13,245	26	169			8	1,563	2	2	2	8	14	3,405	1,332	4,737	13,893	2.9
638	Clinic	13,245	26		169		8	1,393	2	2	2	8	14	3,405	1,332	4,737	13,422	2.8
832	Clinic	13,245	26		169		8	1,393	2	2	2	8	14	3,405	1,332	4,737	13,422	2.8
822	Battalion HQ	60,953	83		350		11	3,790	6	5	10	16	37	9,748	2,664	12,412	35,111	2.8
820	Mess Hall	104,029	50				19	3,261	6	4	8	12	30	6,729	2,664	9,393	26,368	2.8
768	Kanell Hall	44,190	140	231			35	3,875	10	9	16	10	45	9,230	2,664	11,894	33,067	2.8
5001	Airfield Fire House					914	8	5,295	1	22	2	24	49	15,390	2,664	18,054	49,328	2.7
3211	EOQ	19,703	19			86		1,091	3	3		3	9	2,172	1,332	3,504	9,430	2.7
3212	EOQ	19,703	19			86		1,091	3	3		3	9	2,172	1,332	3,504	9,430	2.7

TABLE 3–2
BUILDING ECONOMIC SUMMARY
(Continued)

BLDG NO.	BLDG DESCRIPTION	kWh SVGS. PER YR	kW SVGS. PER YR	MMBtu F.OIL #2 SVGS. PER YR	MMBtu F. OIL #6 SVGS. PER YR	MMBtu LPG SVGS. PER YR	LABOR HOURS SVGS. PER YR	$ COST SVGS. PER YR	DO PNT.	AO PNT.	DI PNT.	AI PNT.	TOTAL BLDG. PNT.	$ CONST. COST	$ ACU COST	$ FIELD HARDWARE COST	TOTAL $ DISC. SAVING	SIR
3213	EOQ	19,703	19			86		1,091	3	3		3	9	2,172	1,332	3,504	9,430	2.7
3214	EOQ	19,703	19			86		1,091	3	3		3	9	2,172	1,332	3,504	9,430	2.7
4052	Administration	5,936	52	26			6	723	2		2	2	6	931	1,332	2,263	6,047	2.7
1714	Gym	69,738	20	466			25	4,866	8	5	8	29	50	12,158	3,996	16,154	42,785	2.6
750	Battalion HQ	66,281	83		367		11	4,000	6	7	10	19	42	11,338	2,664	14,002	37,032	2.6
5004	Air Force Ops	10,149	20			74	8	947	2	2	3	2	9	1,842	1,332	3,174	8,190	2.6
741	Brigade HQ	14,823	63		78		6	1,215	3	1	5	4	13	2,895	1,332	4,227	10,826	2.6
625	Battalion HQ	13,694	79		214		11	1,984	4	4	4	11	23	6,145	1,332	7,477	18,779	2.5
658	Battalion HQ	13,694	79		214		11	1,984	4	4	4	11	23	6,145	1,332	7,477	18,779	2.5
825	Battalion HQ	13,694	79		214		11	1,984	4	4	4	11	23	6,145	1,332	7,477	18,779	2.5
4104	BEQ					189	3	1,120		2	2	4	8	2,917	1,332	4,249	10,402	2.4
1391	Reserve Maintenance	1,773				95		577	2		2	2	6	866	1,332	2,198	5,338	2.4
1769	Barracks	6,987	24	60			3	702	2	1	1	1	5	1,230	1,332	2,562	6,122	2.4
1701	Administration/Supply	23,383	12	132			18	1,709	7	1	7	11	26	5,078	1,332	6,410	14,794	2.3
1706	Administration/Supply	23,383	12	132			18	1,709	7	1	7	11	26	5,078	1,332	6,410	14,794	2.3
1707	Administration/Supply	23,383	12	132			18	1,709	7	1	7	11	26	5,078	1,332	6,410	14,794	2.3
1721	Dayroom	9,291	3	81			8	839	2	2	3	2	9	1,962	1,332	3,294	7,387	2.2
1727	Dayroom	9,291	3	81			8	839	2	2	3	2	9	1,962	1,332	3,294	7,387	2.2
1736	Dayroom	9,291	3	81			8	839	2	2	3	2	9	1,962	1,332	3,294	7,387	2.2
1760	Dayroom	9,291	3	81			8	839	2	2	3	2	9	1,962	1,332	3,294	7,387	2.2
1770	Dayroom	9,291	3	81			8	839	2	2	3	2	9	1,962	1,332	3,294	7,387	2.2
1772	Dayroom	9,291	3	81			8	839	2	2	3	2	9	1,962	1,332	3,294	7,387	2.2
5267	Dispatch	10,113	14			173	11	1,521	4		5	11	20	4,809	1,332	6,141	13,535	2.2
5007	Hanger	8,263	16			403	8	2,727	16	2	17	15	50	7,713	3,996	11,709	24,924	2.1
1712	Chapel	86,052	22	413			23	4,966	7	17	9	31	64	17,076	3,996	21,072	43,195	2.0
1700	Storage	137		155				846	6		6	6	18	2,598	1,332	3,930	7,977	2.0
4110	BOQ			158			3	915		2	2	4	8	2,917	1,332	4,249	8,565	2.0
4111	BOQ			158			3	915		2	2	4	8	2,917	1,332	4,249	8,565	2.0
4112	BOQ			158			3	915		2	2	4	8	2,917	1,332	4,249	8,565	2.0
4113	BOQ			158			3	915		2	2	4	8	2,917	1,332	4,249	8,565	2.0
4114	BOQ			158			3	915		2	2	4	8	2,917	1,332	4,249	8,565	2.0
4115	BOQ			158			3	915		2	2	4	8	2,917	1,332	4,249	8,565	2.0
604	Wallace Pool		41				19	603	2		6		8	1,257	1,332	2,589	4,893	1.9
844	Brigade HQ	71,797	60		509		13	4,658	4	29	5	32	70	21,045	5,328	26,373	44,157	1.7
2240	MP Kennel	2,446	4			68	6	582	4		4	4	12	1,797	1,332	3,129	5,193	1.7
5002	Airline Terminal	9,674	23			31	6	672	5		5	4	14	2,104	1,332	3,436	5,664	1.6
2250	Motor Pool	4,942		100			6	778	3	2	2	5	12	3,028	1,332	4,360	7,032	1.6
404	Telephone Exchange	14,165	75			54	11	1,323	3	3	7	12	25	6,192	1,332	7,524	11,092	1.5
838	Battalion HQ	10,994	64		68		11	1,173	3	4	5	8	20	5,820	1,332	7,152	10,361	1.4
627	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
628	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
629	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
634	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
635	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
651	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
652	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
654	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
659	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4

TABLE 3–2
BUILDING ECONOMIC SUMMARY
(Concluded)

BLDG NO.	BLDG DESCRIPTION	kWh SVGS. PER YR	kW SVGS. PER YR	MMBtu F.OIL #2 SVGS. PER YR	MMBtu F. OIL #6 SVGS. PER YR	MMBtu LPG SVGS. PER YR	LABOR HOURS SVGS. PER YR	$ COST SVGS. PER YR	DO PNT.	AO PNT.	DI PNT.	AI PNT.	TOTAL BLDG. PNT.	$ CONST. COST	$ ACU COST	$ FIELD HARDWARE COST	TOTAL $ DISC. SAVING	SIR
660	Barracks, with a/c	1,811	54		309		22	2,156	6	10	8	17	41	12,431	2,664	15,095	21,384	1.4
199	Sewage Plant						16	297			2		2	397	1,332	1,729	2,410	1.4
183	Sewage Plant						16	297			3		3	418	1,332	1,750	2,410	1.4
9000	Front Gate	989	15			44	9	532	5		5	4	14	2,104	1,332	3,436	4,624	1.3
1013	Barracks			96			12	745	4	3	4	3	14	3,703	1,332	5,035	6,737	1.3
1014	Barracks			96			12	745	4	3	4	3	14	3,703	1,332	5,035	6,737	1.3
1015	Barracks			96			12	745	4	3	4	3	14	3,703	1,332	5,035	6,737	1.3
1016	Barracks			96			12	745	4	3	4	3	14	3,703	1,332	5,035	6,737	1.3
1028	Barracks			96			12	745	4	3	4	3	14	3,703	1,332	5,035	6,737	1.3
1029	Barracks			96			12	745	4	3	4	3	14	3,703	1,332	5,035	6,737	1.3
320	Administration	6,017	15	69			10	805	5	4	7	4	20	3,926	1,332	5,258	7,027	1.3
1725	Barracks	3,549	13	25			3	359	2	1	1	1	5	1,230	1,332	2,562	3,089	1.2
1702	Administration/Supply	117,625	24	946			38	8,945	11	81	7	91	190	55,474	13,320	68,794	79,306	1.2
187	Sewage Plant						32	594			15	2	17	2,964	1,332	4,296	4,819	1.1